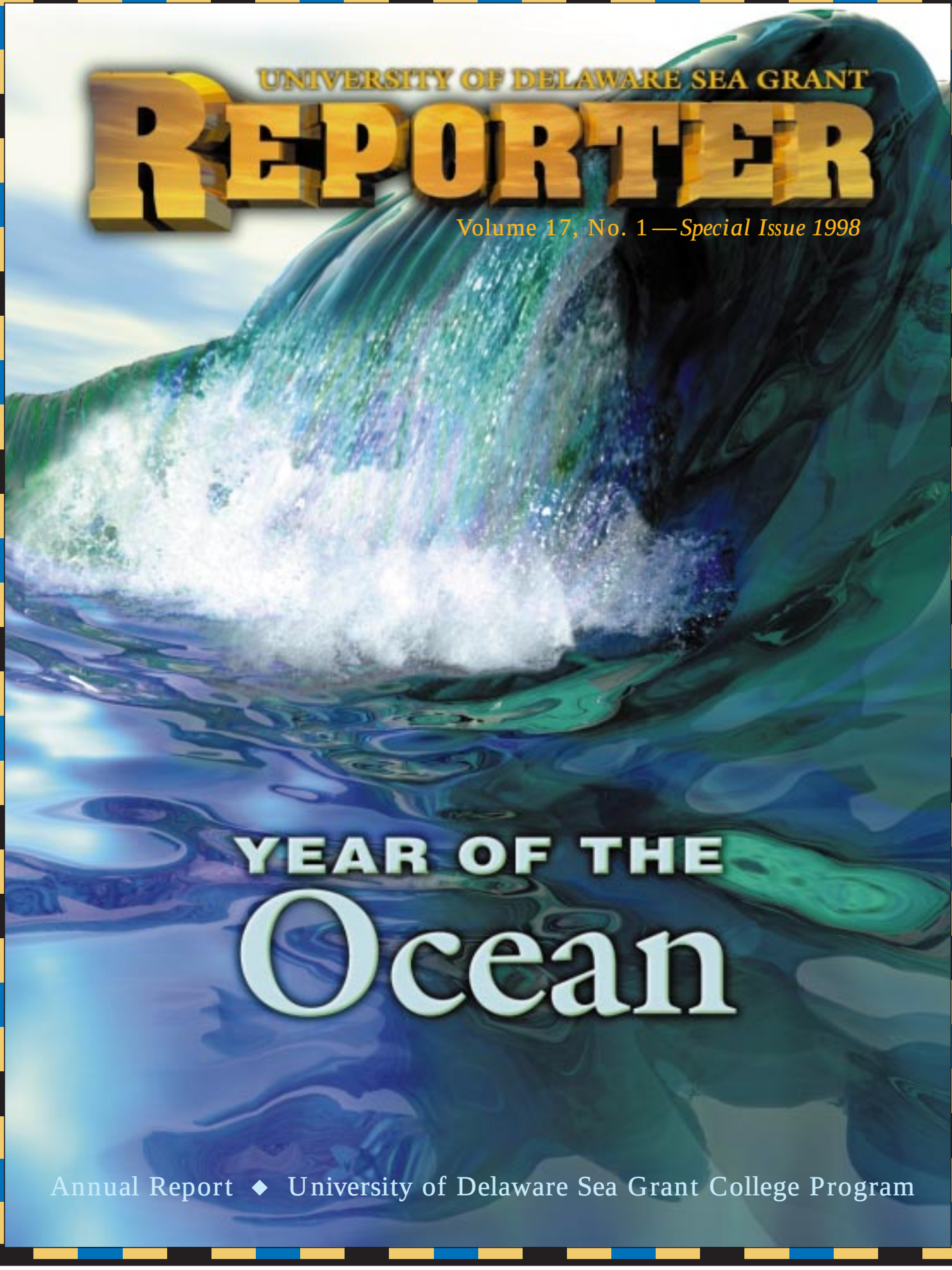
UNIVERSITY OF DELAWARE SEA GRANT
REPORTER
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YEAR OF THE
Ocean
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REPORTER

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MESSAGE FROM THE DIRECTOR

Dr. Carolyn A. Thoroughgood
Director, *University of Delaware Sea Grant College Program*

This year marks a special one for the marine and coastal resources we all love. It's the International Year of the Ocean, so proclaimed by the United Nations in recognition of the importance of the marine environment to everyone on the planet.

Sea Grant staff from around the nation recently met at the University of Delaware to share information about Geographical Information Systems (GIS) and other advanced technologies for coastal monitoring.

Here are a few facts that help underscore the importance of the ocean in our lives:

- More than half the U.S. population lives and works within 50 miles of the coastline.
- One of every six jobs in the United States is marine-related. One-third of our nation's gross domestic product is produced in coastal areas through fishing, transportation, recreation, and other industries that depend on healthy waters and marine habitats.
- Beaches are the leading tourism destination in the United States, with about 180 million people visiting the coast each year.

Delaware Sea Grant is taking part in a regional initiative to educate citizens about Pfiesteria, *the fish-killing organism.*

Here at the University of Delaware Sea Grant College Program, our goal is to promote the wise use, conservation, and management of our ocean resources through the highest-quality research, graduate student education, and public service.

Currently, our scientists are conducting research in coastal processes/engineering, marine biotechnology, environmental studies, fisheries, and public policy. Their efforts are targeted on major issues critical to Delaware and to the nation, from beach erosion to horseshoe crab conservation, from the development of new environmental monitoring technologies to rapidly assess coastal ecosystem health, to advancing research and education about the fish-killing organism *Pfiesteria*.

Milen Dyoulgerov and Maria Honeycutt, graduate students at the University of Delaware Graduate College of Marine Studies, were selected for the year-long Knauss Sea Grant Fellowship on Capitol Hill this year. Dyoulgerov is fostering international cooperation in managing ocean resources in the National Oceanic and Atmospheric Administration's Office of International Programs. Honeycutt is working in the Mitigation Directorate of the Federal Emergency Management Agency, where she is focusing on hurricane damage prevention and other issues.

Coast Day, held the first Sunday in October at the University of Delaware's Lewes campus, educates more than 10,000 visitors each year about marine resources.

Our marine outreach team — the Marine Advisory Service and Marine Communications staff — help translate and disseminate Sea Grant research results to business owners, educators, and many other citizens through workshops, publications, our *SeaTalk* radio series, World Wide Web site, and award-winning Coast Day festival. This year, we're also hosting special Year of the Ocean activities to encourage even more Delawareans to "get their feet wet" in marine science.

Without a healthy ocean and coast, our Diamond State would lose much of its brilliance. During this Year of the Ocean, please join us in learning more about Delaware's coastal treasures and how we can protect and preserve them for future generations.

Carolyn A. Thoroughgood

Dr. Carolyn A. Thoroughgood
Director, Sea Grant College Program
Dean, Graduate College of Marine Studies

The 120-foot Cape Henlopen, *flagship of the University of Delaware, supports a variety of Sea Grant research in coastal waters.*

While the coast ranks as our favorite place to live and visit — more than half the U.S. population lives within 50 miles of the coast, and beaches are the chief tourism destination in the nation — the coast is under constant siege from wind, waves, and sea-level rise. Improper coastal development also exacerbates erosion problems, particularly during hurricanes and other major storms.

The goal of coastal engineering research at the University of Delaware Sea Grant College Program is to develop the means to predict the behavior of the shoreline under short-term conditions, such as during storms, and under long-term scenarios, decades into the future. We're also working to assess the costs and benefits of various methods that are used to manage and protect beaches, such as beach nourishment.

Besides providing critical habitat for horseshoe crabs and other marine life, Delaware's beaches help fuel the state's economy. In 1990, an estimated $165 million dollars was spent by tourists in a nine-month period at our popular resorts from Rehoboth Beach to Fenwick Island.

Economist George Parsons is measuring the economic value of Mid-Atlantic beaches.

Where Do You Go to the Beach?

More than 5 million people visited Delaware's beaches last year. That's about seven times the state's entire population.

Last fall, George Parsons, an economist at the University of Delaware Graduate College of Marine Studies, sent a survey to 1,000 residents in the Mid-Atlantic region to find out which beaches they visit. He and graduate student Matt Massey are now analyzing the results to measure the economic value of Mid-Atlantic beaches.

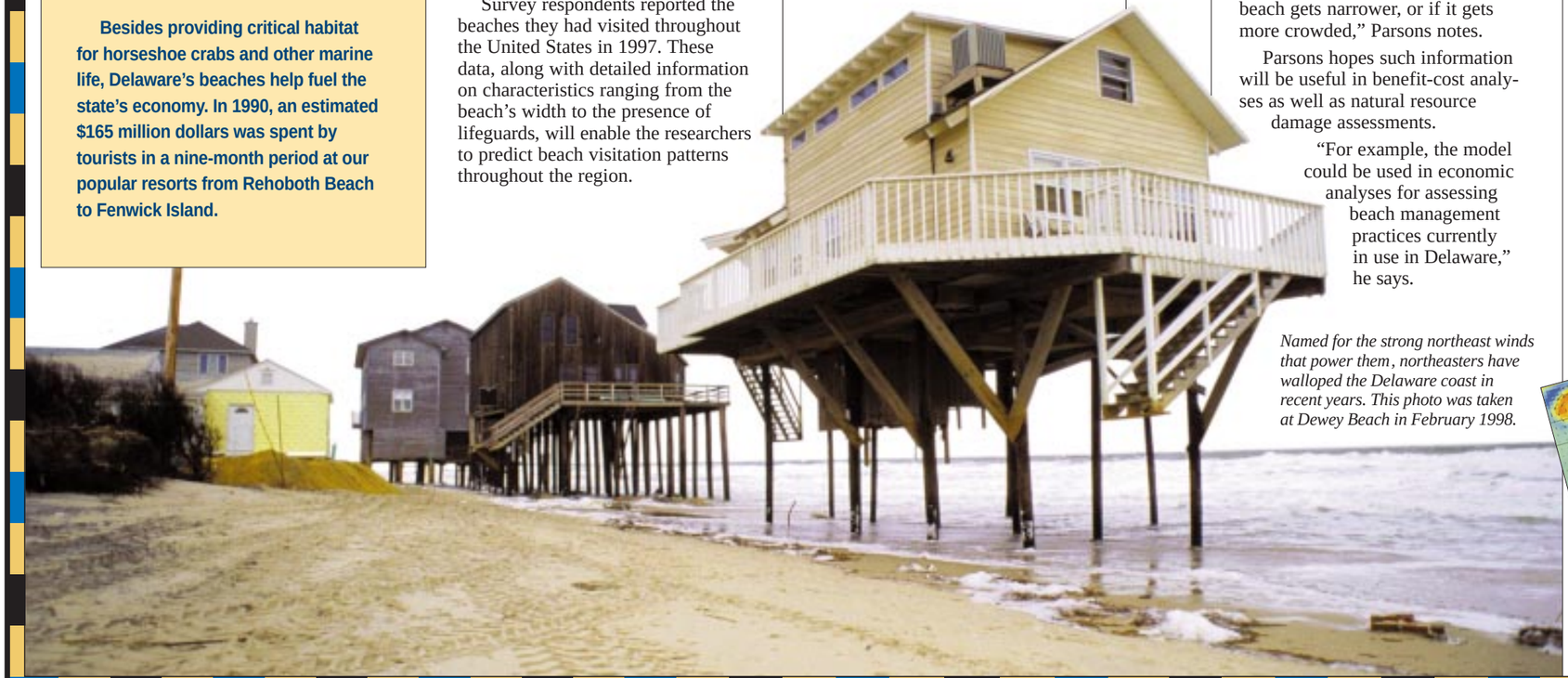
Survey respondents reported the beaches they had visited throughout the United States in 1997. These data, along with detailed information on characteristics ranging from the beach's width to the presence of lifeguards, will enable the researchers to predict beach visitation patterns throughout the region.

More importantly, the model may be used to predict changes in visitation patterns in the case of events such as beach closings or loss of beach width.

"The model also will enable us to estimate the change in economic value of beaches when certain characteristics change, such as if the beach gets narrower, or if it gets more crowded," Parsons notes.

Parsons hopes such information will be useful in benefit-cost analyses as well as natural resource damage assessments.

"For example, the model could be used in economic analyses for assessing beach management practices currently in use in Delaware," he says.



Named for the strong northeast winds that power them, northeasters have walloped the Delaware coast in recent years. This photo was taken at Dewey Beach in February 1998.

Recovering from Coastal Disasters: Who Gets Relief?

When the weather is good, the coast offers the perfect combination of sea and sunshine. But when a hurricane warning is issued, the vulnerability of the coast quickly becomes apparent.

From 1953, the year the first Presidential disaster declaration was issued, to September 1989, the United States never experienced a disaster costing more than $1 billion in federal relief funds. Since then, however, there have been 10 disasters exceeding $1 billion or more in loss, with Hurricane Andrew representing the nation's most costly calamity.

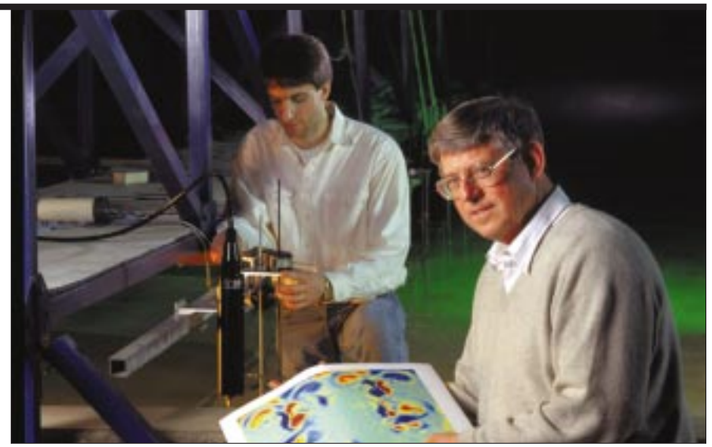
Political scientist Rick Sylves is assessing federal disaster relief in coastal states.

Rick Sylves, a political scientist at the University of Delaware, is reviewing the frequency and duration of coastal disasters, the magnitude of their loss, and the history of disaster relief spending on federal to local levels in America's 30 coastal states.

"Since 1953, there have been about 2,000 gubernatorial requests for Presidential declaration of major disaster or emergency, most of them from coastal states," Sylves says. "About a third have been denied."

Sylves has completed a series of statistical summaries and maps that will help tell the story of coastal disaster relief to government officials.

"My hope is that by knowing the disaster record, public officials will have an even greater appreciation for the need to protect coastal inhabitants, resources, and property," he says. "I also hope to provide information that will help governors better understand why disaster declarations may be turned down."



As graduate student Kevin Haas adjusts a gauge in the directional wave basin, coastal engineer Ib Svendsen reviews a printout showing the rip currents modeled by the SHORECIRC computer program he and his students have developed at the University of Delaware Center for Applied Coastal Research.

Computer Program May Prove "Shore Bet" in Predicting Coastline Changes

Coastal engineers face the formidable task of sorting out the hydrodynamics of the waves and currents that occur nearshore and translating their complex motions into mathematical and physics equations.

These equations then form the basis of computer models that are used by coastal engineers and resource managers to predict shorelines, as well as the performance of coastal protection methods that may range from jetties to beach nourishment projects.

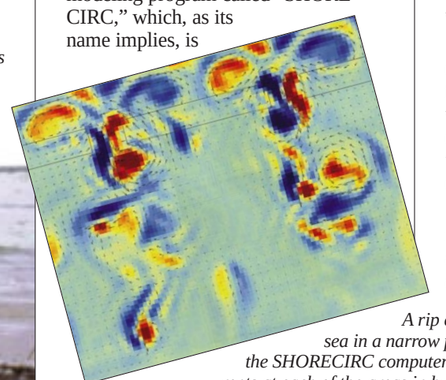
University of Delaware coastal engineer Ib Svendsen and his students have developed a promising computer modeling program called "SHORECIRC," which, as its name implies, is designed to simulate circulation processes near the shore.

Currently, Svendsen and his students are testing the model's ability to elucidate the hydrodynamic mechanisms involved in rip current generation and evolution.

"Rip currents are among the most feared coastal phenomena because they can carry swimmers out to sea, causing many to drown," says Svendsen. "Coastal engineers recognize rip currents as an important element in the nearshore circulation balance, particularly during storms. Nevertheless, few measurements are available that describe where and when these currents occur."

Through extensive laboratory experiments in the University's 66-foot-long-by-66-foot-wide directional wave basin, Svendsen and his students hope to begin solving some of the mysteries of this fascinating, yet often treacherous phenomenon.

"Today's commercial models are not able to provide information about rip currents," he notes. "We are trying to fill that void."



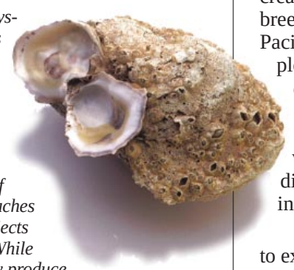
A rip current occurs when water rushes out to sea in a narrow path. In a recent laboratory experiment, the SHORECIRC computer model verified the formation of rip currents at each of the areas in bright red on this printout.

Broadly defined, marine biotechnology is the use of marine organisms or their components to provide goods or services.

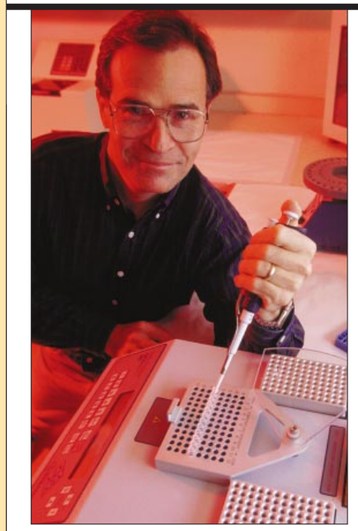
Nationally, Sea Grant scientists have helped advance the U.S. effort in marine biotechnology through a number of achievements, from developing anti-cancer drugs from marine algae, to genetically engineering microbes for use in cleaning up oil spills.

Here at the University of Delaware Sea Grant College Program, marine biotechnology research began in the 1970s, when our scientists began working on a regional waste disposal problem of the seafood industry: blue crab shells. Our scientists discovered a polymer in the blue crab's shell, called *chitin,* that could be spun into fibers for use in surgical sutures, bandages, and other high-value products.

Today, Delaware Sea Grant researchers are conducting a variety of marine biotechnology research, from examining the shipworm's biology at the molecular level to figure out better methods of controlling this pest, to searching out genes for disease resistance that will help the Mid-Atlantic oyster population begin to recover.



The American oyster is the species native to the Delaware and Chesapeake bays. This rough-looking oyster may reach a length of 10 inches. It attaches itself to hard objects with a cement. While each female may produce up to 100 million eggs, this oyster has been decimated in the Mid-Atlantic region by the parasites MSX and Dermo, which attack the animal's circulatory system, often eventually causing death.



Marine biologist Patrick Gaffney is working to give oysters the genes they need to fight off MSX and Dermo, two parasites that have decimated the Delaware fishery.

Giving Oysters a Fighting Chance

The parasites MSX and Dermo are harmless to humans but lethal to oysters. The two diseases have decimated a Delaware Bay fishery that in its heyday hauled in over 3 million bushels per year.

To increase our native oyster's resistance to the diseases, marine biologist Patrick Gaffney from the University of Delaware Graduate College of Marine Studies is working with colleagues in the region on two strategies. One approach is to create a disease-resistant hybrid by breeding our native oyster with the Pacific oyster. The other is to explore the genetic diversity within our native oyster, which ranges from Nova Scotia to the Gulf states, to determine if any individuals in the species can resist disease and thus be used in breeding programs.

"While I don't think it's realistic to expect the oyster industry in the Delaware and Chesapeake bays to ever be what it was years ago," Gaffney says, "disease-resistant oysters could help the industry regain some lost ground."

Sorting Out the Policy Implications of Marine Biotechnology

While marine biotechnology has led to significant advancements in medicine and other areas, it also raises serious legal, ethical, and safety questions.

For example, who should have access to the ocean jurisdictions of coastal nations for the prospecting of marine organisms? Or how should biotechnology be used in the production of aquacultured seafood?

Marine policy professors Biliana Cicin-Sain and Robert Knecht of the University of Delaware Graduate College of Marine Studies are wrapping up a three-year study that has examined these weighty issues as they apply to the marine realm.

With the help of an interdisciplinary team of experts, the scientists examined issues of access to marine organisms, biosafety, and intellectual property rights regarding biotechnological applications ranging from aquaculture to marine pollution control.

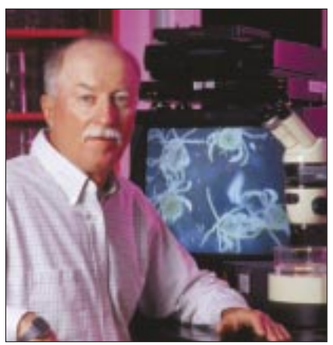
Marine policy professor Biliana Cicin-Sain is co-authoring a book on the policy implications of marine biotechnology.

"There is no question that marine biotechnology holds great promise in improving human lives," says Cicin-Sain. "By addressing policy, regulatory, and ethical issues early on, we're hoping to help government and industry better prepare for and respond to these issues in the best interests of the public and the marine environment."

Currently, Cicin-Sain and Knecht are preparing a book based on their Sea Grant research for Island Press.

What Cues Baby Crabs to Settle Down and Behave Like Adults?

Marine biologist Charles Epifanio and his colleagues at the University of Delaware Graduate College of Marine Studies want to know what triggers baby crabs to settle to the bay bottom, where they metamorphose into young adults.



Illuminated on the video screen behind marine scientist Charles Epifanio are several mud crabs in their larval stages.

Knowing the answer could not only shed light on the basic life processes that govern certain shellfish, but also provide clues to controlling such pests as the mud crab, which preys on oysters and clams.

In a series of lab experiments during the past year, Epifanio and his team introduced larval mud crabs to clean rocks and shells as well as to materials covered with the natural bacterial slime, or *biofilm,* that rapidly coats objects submerged in seawater.

"The results were striking," Epifanio says. "The clean materials had no effect on the larvae, but the structures covered with biofilm induced the crabs' metamorphosis to the next stage of life."

The researchers also found that exudates from adult mud crabs as well as from a predator — the blue crab — induced the mud crab babies to mature.

Currently, the research team is working to isolate these chemical cues. If the chemical recipes can be identified, they may foster new controls for mud crabs.

Shipworm Researchers Find Exciting Answers to "Boring" Problem

The shipworm would be the perfect monster for a horror film set in a forest. This animal loves to bore wood. But ironically, if it weren't for some special bacteria that live in one of its glands, it could never digest its prey.

"Shipworms can digest wood only because of the symbiotic relationship they have with these bacteria," says molecular biologist Craig Cary of the University of Delaware Graduate College of Marine Studies. "While the shipworm provides the bacteria with a home, the bacteria provide the shipworm with the enzymes it needs to digest cellulose, the chief component of wood."

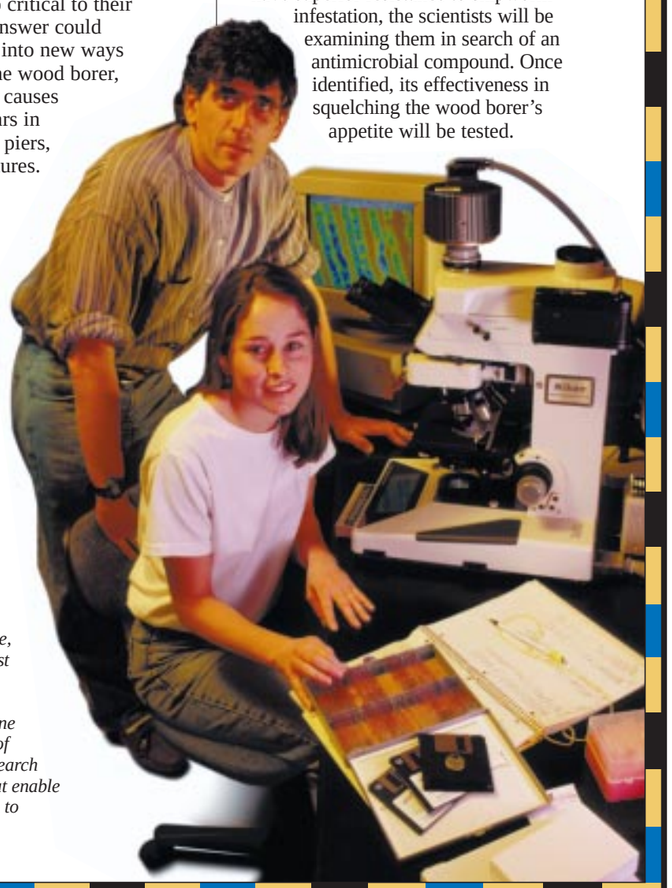
But how do shipworms acquire the microbes so critical to their survival? The answer could provide insight into new ways of combating the wood borer, which annually causes billions of dollars in damaged ships, piers, and other structures.

To find out, Cary and graduate student Alison Sipe set up a shipworm culture facility and constructed molecular probes to help them search out the shipworm's microscopic partners in crime.

Based on the scientific literature, the scientists thought their quarry would be only one kind of bacteria. But in a startling discovery, Sipe has found that each of the three shipworm species she has examined so far has its own unique bacterial partner. From one of these shipworm species, she has successfully isolated a novel strain of bacteria that has not been cultivated before.

The scientists also think they've determined at least how one shipworm species, native to the West Coast, acquires its bacteria. Cary says the microbes appear to be carried on from one generation to the next in the shipworm's eggs.

At this point, with shipworm bacteria in culture, Cary and Sipe will begin testing the microbes' sensitivities to various compounds extracted from wood. Since certain tropical woods have superior resistance to shipworm infestation, the scientists will be examining them in search of an antimicrobial compound. Once identified, its effectiveness in squelching the wood borer's appetite will be tested.



Using an epifluorescent microscope, molecular biologist Craig Cary and graduate student Alison Sipe examine the gill filaments of the shipworm in search of the bacteria that enable the pesky creature to digest wood.

More than half the U.S. population lives within 50 miles of the coast, yet coastal areas account for only 11% of the nation's land area.

A healthy marine environment is critical to Delaware's future. Our coastal treasures include more than 260 miles of saltwater shoreline; about 90,000 acres of tidal wetlands; two National Estuaries — the Delaware Bay, and the Inland Bays; the busiest canal in the nation — the Chesapeake and Delaware Canal; and 24 miles of beaches along the Atlantic Ocean.

Currently, University of Delaware Sea Grant researchers are working to transform the marsh reed *Phragmites australis* from a nuisance plant into a low-cost sludge buster for local sewage treatment plants. As part of a regional marsh restoration project, we're also studying how the burning and spraying of *Phragmites* in a marsh affects the ecology of marsh creeks. We're examining cross-shore circulation patterns in Delaware Bay to learn more about pollution transport. And we're developing new technologies — from a diagnostic probe, to satellite techniques — to rapidly assess the health of coastal ecosystems.

Going with the Flow in Delaware Bay

With the last current meter safely deployed in Delaware Bay, oceanographer Kuo-Chuin Wong breathes a sigh of relief. The sphere-shaped instrument (shown below) will provide him with data on the bay's little-known cross-shore circulation patterns.

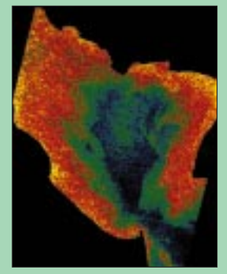
"Most people think of circulation in estuaries like the Delaware Bay as a simple southerly movement, with water traveling through the channel," says Wong. "But there are also cross-bay circulation patterns that help distribute salt, nutrients, and pollutants in Delaware Bay."

Wong's research has confirmed the existence of two branches of brackish outflow in the shallow areas along the bay's shores, separated by a much saltier inflow in the deep channel. He also has discovered that a down-estuary wind strengthens this pattern, while an up-estuary wind greatly weakens it.

"What this means is that the Delaware Bay's circulation is more complex than most of us realized," Wong notes. "A better understanding of the bay's circulation system can help us in many ways. For example, we can better predict the path of disasters such as oil spills to speed their cleanup."

Oceanographer Kuo-Chuin Wong (left) and assistant director of marine operations Art Sundberg prepare to deploy a current meter in Delaware Bay. Equipped with electrodes that sense changes in the water current by changes in the electromagnetic field, this device also can measure water temperature and salinity.

Advancing New Technologies to Assess Coastal Health



This satellite image reveals suspended sediment concentrations in Delaware Bay on March 6, 1987. Yellow and red represent the heaviest concentrations.

Satellites can easily detect concentrations of chlorophyll — a key water-quality indicator — in the open ocean.

But in estuaries like the Delaware Bay, bottom sediments and runoff suspended by the tides interfere with chlorophyll's spectral signature, making water-quality assessments by satellite difficult.

To overcome this limitation, scientists in Delaware Sea Grant's Coastal Ecosystem Health Project have developed a new data processing method using a *neural network*, which can sort out patterns and "learn" from trial and error.

Modeled after the brain's system of neurons, neural networks have been used to perform such tasks as foreign language translation.

To enable their neural network to discern chlorophyll versus suspended sediment concentrations in Delaware Bay satellite images, researchers primed it with a training set of data from actual water-quality measurements taken in the bay. The network then used the data to calibrate its patterns to correctly interpret future inputs.

The Coastal Ecosystem Health Project is led by an interdisciplinary team of experts in satellite oceanography, marine policy, and outreach from the University of Delaware, with input from state coastal managers.

The project's goal is to develop techniques that managers can use to improve ecosystems from the St. Jones River watershed, to Delaware Bay.

Marsh "Weed" Turns Over New Leaf to Become Sludge Buster

Many tourists consider the plant to be beautiful, its tasseled, blue-green stalks turning to gold in winter. But *Phragmites australis* is regarded as a scourge by resource managers because it has overtaken thousands of acres of Delaware's marshes, crowding out more desirable plants that provide wildlife with food and habitat.

Lately, however, it appears that *Phragmites* may be turning over a new leaf. Capitalizing on the extensive root system that makes the plant such a wetlands pest, scientist Jack Gallagher is putting *Phragmites* to work as a sludge buster at sewage treatment facilities in Bridgeville and Delmar.

"What *Phragmites* does is speed up the drying and decomposition of the treated waste, leaving less sludge to haul away," says Gallagher, who is a botanist at the University of Delaware Graduate College of Marine Studies.

The 2,000 plants he and graduate student Tamara Saltman helped install at Bridgeville's facility three years ago have multiplied to 29,000 plants. So far, these plants have saved the Bridgeville facility $2,000 a year.

Botanist Jack Gallagher inspects the Phragmites *growing in a sludge bed at the Delmar Wastewater Treatment Plant.*

The scientists are also testing a variegated strain of *Phragmites*, with yellow-striped leaves, to determine if it can break down sludge even faster than its wild cousin. So far, they've found the variegated strain, which they developed, to be as effective a sludge buster as the wild type.

They also say the variegated *Phragmites* may be a better choice for planting in open-air sludge beds. Since the variegated plant is sterile, it can't change its stripes to become a marsh eater.

Using a glass plate, botanist Denise Seliskar (left) and postdoctoral fellow Wendy Carey collect the film on a Delaware marsh creek.

Film Reveals Status of Marsh Recovery

It takes teamwork to collect and analyze the biological films that form on the surface of a marsh creek, as botanist Denise Seliskar and postdoctoral fellow Wendy Carey can tell you. Over 12-hour tidal cycles, the two scientists from the University of Delaware Graduate College of Marine Studies continuously dip a glass plate into the marsh creek to collect the film on the water surface. Back in the lab, microscopic and chemical analyses are done on the film and underlying water.

The films that float on the surface of a marsh creek often contain algae and other nutrient-rich material that provide a concentrated food source for fish and other animals. But up to now, these nutritious films largely have been ignored in marsh ecology.

"We found that the surface films were much richer biologically than the water beneath them," Seliskar notes. "Last July, for example, we observed thousands of algal cells per milliliter in the film on one creek compared to very few in the water column below."

Her and Carey's research also indicates that a marsh does recover well from spraying and burning for the marsh nemesis *Phragmites*.

"While the spraying and burning of the marsh to control this plant may put a temporary lull on things," Seliskar says, "our films show that the ecology of the marsh creeks does come back to rival that of natural creeks."

Probing for Answers to Chemistry Questions

George Luther inserts the glass tube into the flame of the Bunsen burner and extrudes one end into a fine taper. Next, a gold wire plated with mercury will be introduced into the glass and carefully sealed under the burner's steady glow.

Once completed, the device — a microelectrode — can be inserted into seawater, sediments, or even bacterial films to quickly measure a number of highly reactive chemicals and metals that can reveal an ecosystem's health, including dissolved oxygen, hydrogen sulfide, iron, and manganese. Previous probes could characterize only gaseous compounds, and typically only one gas could be measured per microelectrode.

During the past year, Luther, an oceanographer at the University of Delaware Graduate College of Marine Studies, has been working on a new probe to measure nitrate and ammonia, reactive forms of nitrogen that can have serious impacts on the health of coastal waters. He also recently tested the original microelectrode's sea legs. Last summer, it was deployed on a remotely operated vehicle to analyze seafloor sediments in real time off the New Jersey coast.

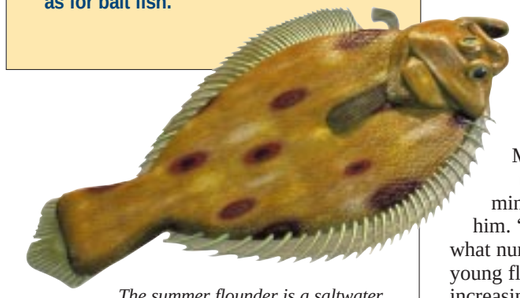
The microelectrode that oceanographer George Luther is constructing can be used to quickly assess the health of marine habitats ranging from bays and marshes to the ocean bottom.

The United States is the world's fifth largest seafood harvester, posting 9.6 billion pounds in commercial landings in 1996, valued at $3.5 billion.

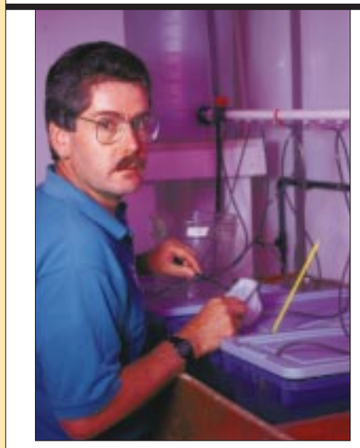
Unfortunately, however, most commercial fish stocks in U.S. waters and around the world are in serious decline, with many in dire need of rebuilding.

Here at the University of Delaware Sea Grant College Program, we're working to understand how physical and biological factors affect the feeding, growth, and survival of important Mid-Atlantic fisheries ranging from blue crabs to summer flounder. We're also working to relieve fishing pressure on the horseshoe crab, a critical Delaware Bay resource that is being used as eel and whelk bait, by creating an artificial bait that chemically mimics it.

To keep up with the growing demand for seafood, aquaculture must continue to grow. Sea Grant research is now under way at Delaware State University to determine optimal growing conditions for native crayfish, as well as for bait fish.



The summer flounder is a saltwater fish that ranges from Nova Scotia to Florida, but it is most abundant in waters from Massachusetts to North Carolina. The summer flounder is called a "left-sided" flatfish because both of its eyes are on the left side of its head. This fish rests on the sea bottom, using color adaptation to blend in with its surroundings. It also may partially bury itself in the bottom sand and sediments for camouflage. Summer flounder feed on fish and shrimp. This species reaches a maximum size of 3 feet long and 26 pounds.



In a series of lab experiments, fisheries scientist Tim Targett is defining the optimal nursery conditions for summer and southern flounder.

What Conditions Fuel Fast Flounder Growth?

The estuaries along the U.S. Atlantic and Gulf coasts provide nursery grounds for numerous fishes. Knowing what environmental conditions help young fish grow best can help resource managers better define and protect critical fish habitat.

"When fish are this young they're extremely vulnerable to predators," says Tim Targett, a fisheries scientist at the University of Delaware Graduate College of Marine Studies, as he nets the 2-inch flounder swimming in the tank in front of him. "We're trying to determine what nursery conditions will help young flounder grow fastest, increasing their odds of survival."

Targett is finishing up experiments that will reveal the optimum temperature and salinity conditions for young summer and southern flounder. Next, he'll examine the effect of turbidity, or water clarity, on the fish. When his research is complete, it will help resource managers define the habitat vital to the early life stages of these two important East Coast fisheries.

Netting the Best Methods for Growing Fish

How do you quickly and economically grow crayfish ready for market, and bait fish ready for sale? Pinpointing the optimum conditions for accomplishing these feats is the goal of Bernie Petrosky and Bill Daniels, aquatic biologists at Delaware State University.

In Delaware State's expansive aquaculture ponds, the scientists are analyzing the growth of mummichogs, a popular bait fish, under different water management regimes.

Figuring out the best system for maintaining good water quality is critical to the success of any aquaculture operation since fish live, eat, and "breathe" in the same water in which they excrete their waste.

"The water-quality information we develop will be applicable to any bait fish," says Daniels. "Growing bait fish may offer farmers, for example, a way to use a farm pond to supplement their incomes without a major investment in labor."

In other research, Petrosky and Daniels are conducting laboratory experiments to determine the best techniques for growing the eastern White River crayfish, the only crayfish native to our area.

"We're working to figure out the production techniques that will enable local fish farmers to produce crayfish year-round," notes Petrosky.

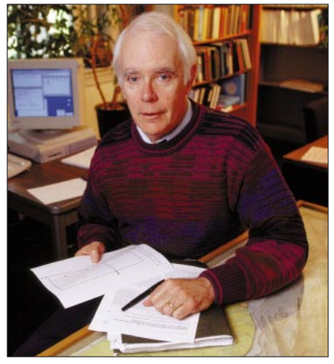
Professors Bill Daniels (foreground) and Bernie Petrosky, and graduate student Wendy Stewart, check the growth of bait fish in a pond at Delaware State University.

Mapping the Voyage of the Baby Blue Crabs

When baby blue crabs hatch in the Delaware Bay in July and August, wind and river flow transport them to the ocean where they spend the first few weeks of their lives. Winds later position large numbers of these larval crabs near the Delaware Bay's mouth where tides help carry them back into the bay to mature.

Oceanographer Richard Garvine and marine biologist Charles Epifanio, of the University of Delaware Graduate College of Marine Studies, have pooled their talents to map the natural forces that dictate the baby blue crab's itinerary in its first few months of life.

Previous research by the scientists has indicated that blue crabs spawned at the mouth of Delaware Bay are carried rapidly southward by the Delaware Coastal Current, which flows out of Delaware Bay, takes a right turn, and then hugs the coast. Some of these crabs are later shuttled northward by summertime winds for re-entry into Delaware Bay.



Using satellite-tracked drifters, oceanographer Richard Garvine is investigating the circulation processes that transport baby blue crabs in and out of the Delaware Bay.

However, Garvine and Epifanio also have identified a "null zone," along the northern mouth of Delaware Bay and southern New Jersey coast, where patches of baby crabs may be found. Using larval crab collectors and satellite-tracked drifters, the scientists hope to determine this zone's impact on the Delaware Bay's most valuable fishery.

Artificial Bait May Take the Pressure Off the Horseshoe Crab

The horseshoe crab lived at the time of the dinosaurs. Yet sharp declines in its population make some fear it may share the same fate as its prehistoric friends.

The horseshoe crab's decline is attributed to factors ranging from the loss of sandy beaches the animal needs to lay its eggs, to overharvesting, particularly of females, for use as eel and whelk bait.

During the past year, Nancy Targett, marine biologist and associate dean at the University of Delaware Graduate College of Marine Studies, has been working to minimize fishing pressure on the horseshoe crab through biochemistry. She has made significant progress toward identifying the stimulant in female horseshoe crabs that makes them such an irresistible bait for eels and whelks. With this information, she wants to develop an artificial bait that will attract eels and whelks just as well as female horseshoe crabs do.

She and her graduate students are in the home stretch in chemically characterizing the attractant. The next step will be to incorporate the compound into a variety of artificial bait types and test their effectiveness. Several commercial fishermen have already contacted Targett, offering to test the baits when they are ready.

"The fishing industry is very supportive of this effort," Targett says. "With their help, our goal is to create an artificial horseshoe crab bait that will work as well as the traditional one. The result should be a win-win situation for the fishermen as well as the horseshoe crab, resulting in more horseshoe crabs for spawning and sustainable uses in medicine."

Marine biologist Nancy Targett is developing an artificial bait that chemically mimics the horseshoe crab to reduce the animal's use as eel and whelk bait.

The Delaware Bay is home to the largest population of horseshoe crabs in the world. Here, freshly spawned horseshoe crab eggs fuel over a million shorebirds on their spring migration north to the Arctic.

In human medicine, one of the creature's most important contributions is a compound in its blood which is used by the pharmaceutical industry to test intravenous drugs for dangerous bacteria. Blood for this test is removed from the horseshoe crab without harming the animal.

Horseshoe crabs come ashore along the Delaware Bay each spring to lay their eggs. Synchronized with their spawning is the arrival of over a million shorebirds from as far away as Tierra del Fuego, at the tip of South America. The birds stop to rest and feed on the protein-rich eggs before continuing their northward migration to Arctic nesting grounds.

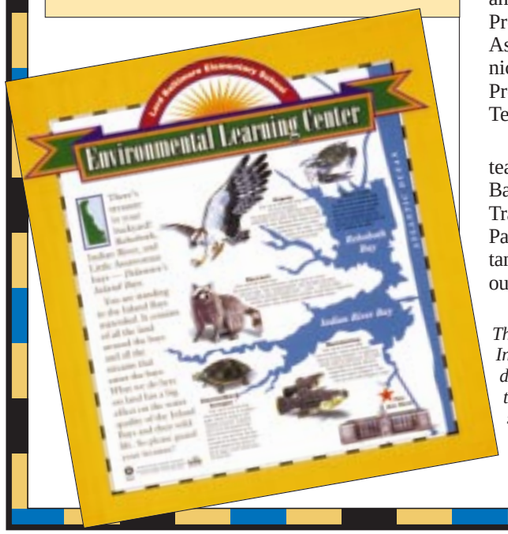
People from all walks of life enjoy the beauty of the ocean and its bounty. As the number of people living near the coast continues to climb, public education about the ocean and its importance will be critical to our future.

Here at the University of Delaware Sea Grant College Program, we have a corps of outreach specialists dedicated to assisting the public with coastal challenges and opportunities: our Marine Advisory Service (MAS) and Marine Communications staffs.

The MAS travels the state to assist Delawareans with issues pertaining to aquaculture, seafood technology, marine education, marine resource management, and marine recreation and tourism.

The Marine Communications staff helps translate Sea Grant research into a variety of publications, communicates our research to the media, produces the *SeaTalk* radio series, develops our Web site at *www.ocean.udel.edu,* and more.

Together, these staffs coordinate our popular celebration of the ocean: Coast Day, held every first Sunday in October at the Lewes campus.



Over the past four years, nearly 25,000 copies of Delaware Sea Grant's horseshoe crab model have been distributed, many to Delaware schoolchildren.

Marine Communications Shares Science with You

The Marine Communications staff, based at the University of Delaware's main campus in Newark, works constantly to help extend marine information to the public.

The five-member staff develops and distributes publications ranging from technical reports to press releases, as well as radio announcements, videos, and Web pages.

Among the staff's accomplishments during the past year were the proceedings of a public forum on horseshoe crabs; fact sheets on topics from *Pfiesteria* to El Niño; and media relations activities resulting in coverage by the Associated Press to CNN.

The staff also won awards from the Council for the Advancement and Support of Education, Delaware Press Association, International Association of Business Communicators, National Federation of Press Women, and Society for Technical Communication.

The Marine Communications team includes art director David Barczak, marine outreach coordinator Tracey Bryant, production manager Pamela Donnelly, administrative assistant Kimberly Doucette, and marine outreach specialist Claire McCabe.

Through a grant from the Center for the Inland Bays, Marine Communications developed this four-by-five-foot interpretive sign about the Inland Bays watershed for the Environmental Learning Center at Lord Baltimore Elementary School in Ocean View.

Marine Advisory Service Helps Tackle Coastal Challenges

A typical day with the University of Delaware Sea Grant Marine Advisory Service (MAS) might take you to a workshop to demonstrate safe seafood handling practices to professional chefs in the morning, to a meeting of chamber of commerce members interested in learning more about ecotourism in the evening.

Directing the efforts of the six-person staff is marine biologist Kent Price. A member of the faculty of the University's Graduate College of Marine Studies for the past 31 years, Price conducts a variety of environmental and fisheries research, ranging from the development of a novel artificial reef made of stabilized coal-ash waste, to a present study to examine the effect of nutrient enrichment on the plant and animal communities in Delaware's Inland Bays.

Marine recreation and tourism specialist Jim Falk is working with the Delaware Department of Natural Resources and Environmental Control and the Center for the Inland Bays to develop a water-use plan for Delaware's Inland Bays. The purpose of the plan is to help better manage the diversity of activities in the bays, from crabbing to jet skiing. Using a consensus-building approach, Falk has hosted public meetings to help

Marine Advisory Service Director Kent Price and graduate student Lexia Valdes-Murtha collect seaweed for laboratory analysis. In recent summers, vast crops of seaweed have caused pollution problems along Rehoboth and Indian River bays.

Marine recreation and tourism specialist James Falk (left) and environmental scientist Ben Anderson from the Delaware Department of Natural Resources and Environmental Control map out resource protection areas in the Inland Bays using a Global Positioning System (GPS).

identify and minimize water-use conflicts in the bays in order to design a blueprint for their future. Falk is also helping to coordinate a summer workshop for the state tourism industry on the microorganism *Pfiesteria piscicida,* which was implicated in fish kills in nearby Maryland waters last year.

Marine resource management specialist Joe Farrell is involved in several cooperative projects that are providing interdisciplinary University resources in support of local community problems. In one project, Farrell and colleague Jack Martin, from the University's College of Agricultural Sciences, are characterizing storm water impact on South Bethany's canal system using

Marine resource management specialist Joe Farrell checks the data gathered by the storm water logger recently placed in a drain at South Bethany. Working with him are colleague Jack Martin (below left) of the University's College of Agricultural Sciences and town councilman Sal Aiello.

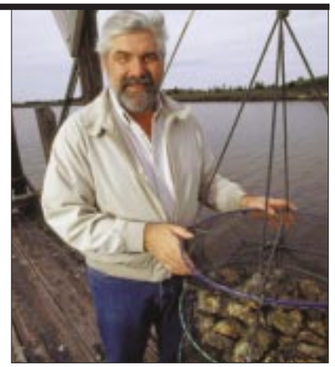
automated water sampling equipment. This project is a result of an earlier collaborative effort between the town and the Inland Bays Citizens Monitoring Program, which Farrell manages, that assessed water quality in the canal system.

Seafood technology specialist Doris Hicks provides seafood handling and preparation information to a variety of groups, from seafood processors to consumers. During the past year, as part of a national Sea Grant alliance, she helped instruct regional seafood processors in the seafood safety techniques of the

Doris Hicks presents a program on safe seafood handling practices at the Seaside Training and Employment Center in Rehoboth Beach. Beside her are chefs Carol Murray of Bridgeville and Chris McNeely of Lewes.

Hazard Analysis Critical Control Point (HACCP) program. Hicks also continues to write the "Seafood Advisor" column for the National Fisheries Institute's *Seafood Source* newsletter, as well as a guest column for the *Cape Gazette* in Lewes. This summer, under the sponsorship of the Northeastern Regional Aquaculture Center, Hicks is coordinating a special program for food educators to promote greater use of aquacultured seafood.

Aquaculture specialist John Ewart operates the Delaware Aquaculture Resource Center in Cannon Laboratory at the University's Lewes campus. Open from 8 a.m. to 4:30 p.m., Monday through Friday, the center offers fish farmers a variety of resource materials, from supply catalogs to instructional videos. Increasingly, fish farmers also are tapping into the resource center's Web site at *darc.cms.udel.edu.* Currently, Ewart is



Aquaculture specialist John Ewart experiments with the use of a lantern net in an oyster grow-out project.

exploring a variety of production techniques for growing oysters in the Inland Bays. Besides serving on the Delaware Aquaculture Advisory Council, he also is coordinating the Northeastern Regional Aquaculture Center's regional extension network.

Marine education specialist Bill Hall helps bring the ocean into Delaware classrooms. Each year, several hundred teachers participate in the marine science workshops he develops with the state Department of Education. This summer, he is coordinating "Operation Pathfinder" for the Mid-Atlantic region. This course, sponsored by the U.S. Navy, introduces kindergarten through twelfth-grade teachers to oceanographic concepts. In addition to drafting popular publications on marine life, Hall also helps organize the horseshoe crab census held annually along Delaware Bay.

Marine education specialist Bill Hall leads elementary school students on a tour of the teaching ship Mimi.

Sea Grant Hosts Lecture Series to Bring Ocean to Public

This past spring, the University of Delaware Sea Grant College Program and the Graduate College of Marine Studies co-sponsored a special lunchtime lecture series, featuring renowned speakers, at the Hotel du Pont in Wilmington.

In March, Dr. JoAnn Burkholder, world expert on Pfiesteria, *updated listeners on the status of the fish-killing organism and research efforts aimed at better detecting it.*

In April, Dr. D. James Baker, administrator of the National Oceanic and Atmospheric Administration in the U.S. Department of Commerce, presented an overview of El Niño and its impact.

The distinguished lecturers for the series included JoAnn Burkholder, the North Carolina State University botanist who is regarded as the world's expert on the fish-killing organism *Pfiesteria piscicida;* D. James Baker, Undersecretary for Oceans and Atmosphere in the U.S. Department of Commerce and administrator of the National Oceanic and Atmospheric Administration; and Sylvia Earle, the pioneering ocean scientist whose accomplishments have ranged from walking on the ocean floor untethered at 1,250 feet — a feat unmatched by any other deep-sea explorer, to founding Deep Ocean Exploration and Research, a company that designs, operates, and consults on manned and robotic subsea systems.

In May, Dr. Sylvia Earle, ocean pioneer, made an urgent plea for the oceans during her talk, "Sea Change: A Message of the Oceans."

The lecture series drew nearly 400 participants, from members of the Wilmington business community, to retirees and students.

The University of Delaware Sea Grant College Program is hosting a number of special events to celebrate the Year of the Ocean, from public lectures featuring renowned marine scientists, to our Coast Day festival in October. We invite you to join us!

We also encourage you to adopt these great stewardship practices, presented by the National Oceanic and Atmospheric Administration (NOAA):

Top 10 Things You Can Do to Help Our Ocean

1. **Learn all you can about the ocean.**
2. **Be a smart shopper. Know the source and quality of your seafood.**
3. **Conserve water.**
4. **Reduce your use of household pollutants, including herbicides, pesticides, and cleaning products.**
5. **Reduce waste. Recycle, re-use, and compost.**
6. **Reduce automobile pollution. Use fuel-efficient vehicles or carpool. Recycle motor oil.**
7. **Protect ocean wildlife. Don't dispose of fishing lines, nets, or plastic items in or near the water.**
8. **Be considerate of sea-life habitats. Don't feed sea birds, mammals, or turtles, or disturb their nesting grounds.**
9. **Get involved. Take part in a beach cleanup or other ocean-oriented activity.**
10. **Care about the ocean! Pass on your knowledge!**

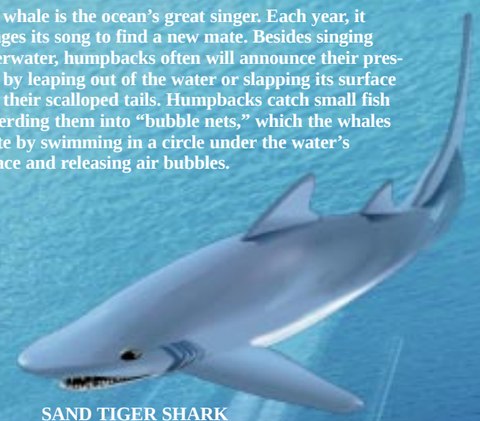
For more information, visit NOAA's Year of the Ocean Web site at www.yoto98.noaa.gov.

HUMPBACK WHALE
(Megaptera novaeangliae)

Size: **Up to 53 ft. long.**

Range: **Atlantic Ocean from Iceland to the West Indies and Gulf of Mexico. Pacific Ocean from Bering Sea to southern Mexico.**

This whale is the ocean's great singer. Each year, it changes its song to find a new mate. Besides singing underwater, humpbacks often will announce their presence by leaping out of the water or slapping its surface with their scalloped tails. Humpbacks catch small fish by herding them into "bubble nets," which the whales create by swimming in a circle under the water's surface and releasing air bubbles.



SAND TIGER SHARK
(Odontaspis taurus)

Size: **Up to 10 ft. long.**

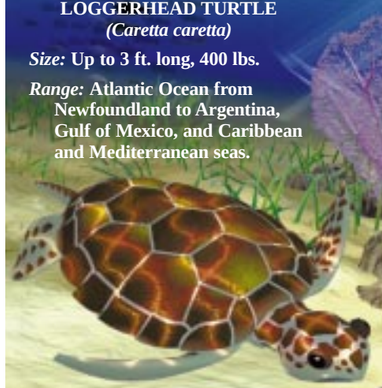
Range: **Western Atlantic from Gulf of Maine to Argentina. Eastern Atlantic off Europe and North Africa and in Mediterranean Sea.**

This shark is the snaggle-toothed species you often see in public aquariums. It swims with its mouth open, exposing three rows of long, three-pronged teeth that are designed for catching small fish. Many sharks must be 15 to 20 years old before they can bear young, called "pups." Many sharks are becoming endangered due to overfishing.

LOGGERHEAD TURTLE
(Caretta caretta)

Size: **Up to 3 ft. long, 400 lbs.**

Range: **Atlantic Ocean from Newfoundland to Argentina, Gulf of Mexico, and Caribbean and Mediterranean seas.**



This is the most common sea turtle in U.S. waters. It's often seen around shipwrecks and reefs, feeding on crabs, jellyfish, and other food. When active, sea turtles must swim to the surface every few minutes to breathe. But when resting, they can stay underwater for as long as two hours without breathing!

TUBEWORMS
(Riftia pachyptila)

Size: **Up to 8 ft. long.**

Range: **Pacific Ocean from Baja to the Galápagos Islands, over a mile deep on seafloor.**

These tubeworms live near super-hot vents on the Pacific Ocean floor. These giant worms tolerate some of the most extreme conditions on Earth: tremendous pressure created by the weight of the mile-high sea above them, and total darkness!

Learn More about Shore at Coast Day

What began as a simple open house in 1977 at the University of Delaware Graduate College of Marine Studies in Lewes is now the single largest educational event hosted by the University of Delaware. It's Coast Day!

Ship tours are just one of the many activities offered at Coast Day.

Coast Day delivers an educational boost to visitors of all ages. Shown here, accompanied by their teachers, are the winners of the 1997 Coast Day fifth-grade essay contest.

At Coast Day 1997, fisheries scientist Tim Targett (left) discusses his flounder research with Ron Baird, director of the National Sea Grant College Program.

Coordinated by the outreach staff of the University of Delaware Sea Grant College Program, Coast Day annually attracts more than 10,000 visitors to the Lewes campus to learn about marine science firsthand through research demonstrations, ship tours, lectures, marine critter touch tanks, and many other activities.

A special Year of the Ocean celebration is in development for our 22nd annual Coast Day on Sunday, October 4, from 11 a.m. to 5 p.m., at the Lewes campus. For more information, call (302) 831-8083 or visit our Web site at *www.ocean.udel.edu.*

Titanic Talk Set for October 14

Mark your calendars now! Oceanographer Robert Ballard will be coming to the University of Delaware's Bob Carpenter Center on Wednesday evening, October 14, to recount his discovery of the *Titanic* on the ocean floor. The lecture will be free and open to the public.

University of Delaware
Sea Grant College Program
Financial Report

July 1, 1997 – June 30, 1998

Program Area	State Funds	Federal & Other Matching
Marine Biotechnology	$ 26,711	$ 119,305
Coastal Processes/Engineering	45,538	163,144
Environmental Studies	32,907	135,780
Fisheries	46,809	146,488
Policy Studies	28,449	114,504
Marine Outreach	226,119	670,902
Graduate Education	0	386,010
Program Management	0	260,834
Totals	**$406,533**	**$1,996,967**
Grand Total		**$2,403,500**

In addition to this funding, University of Delaware Sea Grant investigators successfully competed for several special grants from the National Sea Grant College Program, National Oceanic and Atmospheric Administration, U.S. Department of Commerce. Funds for these projects are managed by Delaware Sea Grant and serve as an important mechanism for the development of comprehensive and integrated research efforts:

- *Marine biologist Patrick Gaffney was awarded $83,000 from the Oyster Disease Program to continue his research on MSX and Dermo and the Mid-Atlantic oyster population.*
- *Marine policy professor Robert Knecht and satellite oceanographer Vic Klemas began the third year of a three-year special enhancement award totaling $1,055,234 to provide resource managers with innovative technologies for monitoring and improving coastal ecosystems such as Delaware Bay. This is a multidisciplinary approach involving GIS/remote sensing, policy studies, and outreach.*
- *Aquaculture professors Bernie Petrosky and William Daniels, at Delaware State University, began the second year of a special three-year award, totaling $150,000, to develop aquaculture methods appropriate to the Mid-Atlantic region for crayfish and bait fish.*
- *Marine policy professors Robert Knecht and Biliana Cicin-Sain began a one-year, $98,000 project to initiate a national dialogue on U.S. national and coastal ocean policy including assessment of the work of the Stratton Commission.*

University of Delaware
Sea Grant College Program
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